What is claimed is:

1. An apparatus for measuring a property of a structure, comprising:

a laser that generates an optical pulse;

a diffractive element that receives the optical pulse and diffracts it to generate at least two excitation pulses;

an optical system that receives at least two optical pulses and spatially and temporally overlaps them on or in the structure to form an excitation pattern that launches an acoustic wave, electronic response, or thermal response that modulates at least a portion of the structure;

a light source that produces a probe beam that reflects off the portion of the structure to generate a signal beam;

an optical detection system that receives the signal beam and in response generates a light-induced electrical signal; and

an analyzer that analyzes the light-induced electrical signal to measure the property of the structure.

2. The apparatus of claim 1, wherein the diffractive element is a mask that comprises an optically transparent substrate that comprises a pattern comprising a series of parallel trenches having a spatial periodicity of between 0.1 and 100 microns.

3. The apparatus of claim 2, wherein the mask is a phase mask.

4. The apparatus of claim 3, wherein the phase mask comprises a plurality of patterns.

5. The apparatus of claim 1, wherein the laser is a diode-pumped laser.

6. The apparatus of claim 5, wherein the laser is a passively Q-switched laser.

7. The apparatus of claim 6, wherein the laser comprises Nd:YAG, titanium:sapphire, chromium:LISAF, or a fiber laser.

8. The apparatus of claim 7, wherein the Nd:YAG is comprised by a layer having a thickness of less than 5 mm.

9. The apparatus of claim 1, wherein the portion of the structure is a surface.

10. The apparatus of claim 9, wherein the acoustic wave generates a time-dependent ripple on the surface.

11. The apparatus of claim 10, wherein the probe beam is aligned to deflect off the time-dependent ripple to form the signal beam.

12. The apparatus of claim 11, wherein the optical detection system comprises a detector that generates an electrical signal that changes when a deflection angle of the probe beam changes.

13. The apparatus of claim 12, wherein the optical detection system comprises a detector that comprises a single photodiode.

14. The apparatus of claim 13, wherein the detector comprises at least two photodiodes.

15. The apparatus of claim 1, wherein the modulated optical, mechanical, or physical property is a temperature.

16. The apparatus of claim 11, wherein an optical, mechanical, or physical property is modulated in the portion by the acoustic waves.

17. The apparatus of claim 16, wherein a refractive index or absorption coefficient is modulated.

18. The apparatus of claim 16, wherein the probe beam is aligned to reflect off the area comprising the modulated absorption coefficient or refractive index.

19. The apparatus of claim 18, wherein the optical detection system is configured to detect a phase of the signal beam.

20. The apparatus of claim 19, wherein the optical detection system comprises an interferometer.

21. The apparatus of claim 1, wherein the optical system comprises at least one lens that collects and overlaps the excitation pulses on or in the structure.

22. The apparatus of claim 21, wherein the optical system comprises a lens pair having a magnification ratio of about 1:1.

23. The apparatus of claim 1, further comprising a lens that focuses the probe laser beam onto the portion.

24. The apparatus of claim 23, wherein the acoustic waves generate a time-dependent ripple morphology in the portion, and the probe beam irradiates a peak, null, a region between a peak or null, or a portion thereof in the ripple morphology.

25. The apparatus of claim 23, wherein the portion undergoes a time-dependent change in refractive index or absorption coefficient.

26. The apparatus of claim 1, wherein the analyzer is configured to determine a frequency or phase velocity of the acoustic waves.

27. The apparatus of claim 26, wherein the structure comprises at least one layer.

28. The apparatus of claim 27, wherein the analyzer is configured to analyze the frequency or phase velocity to determine a thickness of the layer.

29. The apparatus of claim 28, wherein the analyzer is configured to calculate a thickness of the layer by analyzing the frequency or phase velocity, a density of the layer, and a wavelength of the excitation pattern.

30. The apparatus of claim 28, wherein the structure comprises a plurality of layers, and the analyzer is configured to analyze the light-induced electrical signal

to determine the thickness of more than one layer in the structure.

31. The apparatus of claim 27, wherein the analyzer is configured to determine the density, resistivity, adhesion, delamination, elasticity, roughness, or reflectivity of the structure or the layer in the structure.

32. The apparatus of claim 27, wherein the structure comprises a semiconductor.

33. The apparatus of claim 32, wherein the layer is a metal film.

34. The apparatus of claim 33, wherein the metal comprises aluminum, tungsten, copper, titanium, tantalum, titanium:nitride, tantalum:nitride, gold, silver, platinum, or alloys thereof.

35. An apparatus for measuring a property of a structure, comprising:

a passively Q-switched laser that generates an optical pulse;

a photodiode that receives a portion of the optical pulse to generate a trigger pulse;

a first optical system that receives the optical pulse and separates it into at least two excitation pulses; a second optical system that receives at least two optical pulses and spatially and temporally overlaps them on or in the structure to form an excitation pattern that launches an acoustic wave, an electronic response, or a thermal response that modulates at least a portion of the structure;

a light source that produces a probe beam that

reflects or diffracts off the portion to generate a signal beam;

an optical detection system that receives the signal beam and in response generates a light-induced electrical signal;

a data-acquisition system that receives the light-induced electrical signal and the trigger pulse and, in response, generates a data signal; and

an analyzer that analyzes the data signal to measure the property of the structure.

36. The apparatus of claim 35 wherein the first optical system comprises a diffractive element.

37. The apparatus of claim 36, wherein the diffractive element is a phase mask.

38. The apparatus of claim 35, wherein the passively Q-switched laser is a diode-pumped laser.

39. The apparatus of claim 38, wherein the passively Q-switched laser comprises Nd:YAG, titanium:sapphire, chromium:LISAF, or a fiber laser.

40. The apparatus of claim 39, wherein the Nd:YAG is comprised by a layer having a thickness of less than 5 mm.

41. The apparatus of claim 35, wherein an optical, mechanical, or physical property of the structure is modulated in the portion of the structure.

42. The apparatus of claim 41, wherein the probe beam is aligned to deflect or diffract off the optical, mechanical, or physical property to form the signal beam.

43. The apparatus of claim 42, wherein the modulated optical, mechanical, or physical property is a time-dependent surface ripple.

44. The apparatus of claim 42, wherein the modulated optical property is a refractive index or absorption coefficient.

45. A method for measuring a property of a structure, comprising the steps of:

generating an optical excitation pulse with a diode-pumped laser;

diffracting the optical pulses with a diffracting element to generate at least two excitation pulses;

spatially and temporally overlapping the excitation pulses on or in the structure to form an excitation pattern that launches an acoustic wave, an electronic response, or a thermal response that modulates at least a portion of the structure;

reflecting a probe beam off the portion to generate a signal beam;

detecting the signal beam to generate a light-induced electrical signal; and

analyzing the light-induced electrical signal to measure the property of the structure.

46. A method for measuring a property of a structure, comprising:

generating an optical pulse with a passively Q-switched laser;

generating a trigger pulse by detecting a portion of the optical pulse;

separating the optical pulse into at least two excitation pulses;

spatially and temporally overlapping the optical pulses on or in the structure to form an excitation pattern that launches an acoustic wave, an electronic response, or a thermal response that modulates at least a portion of the structure;

reflecting or diffracting a probe pulse off the portion to generate a signal beam;

detecting the signal beam to generate a light-induced electrical signal;

processing the light-induced electrical and the trigger pulse with a data-acquisition system to generate a signal; and

analyzing the signal to measure the property of the structure.